Fire Codes for Global Practice[†]

Fire codes applicable anywhere in the world, based on performance, are now closer to reality. A progress report *by Richard W. Bukowski.* The author is a Senior Research Engineer at NIST's Building and Fire Research Laboratory in Gaithersburg, Maryland

Abstract

Architecture in a world economy, with multinational clients and a global range of building materials and systems, demands fire codes based on performance. The International Council for Building Research is now working on methods to verify compliance under performance-based fire codes. Performance codes will have several advantages: code objectives clearly stated and understood by all parties, and analytical methods, data, and assumptions formalized in a single code of practice.

Introduction

Imagine that a multinational corporation wants you to design for it a signature building that will be reproduced in a dozen countries. Your job will be to develop a single design that complies with the individual fire-code requirements in each nation and satisfies all local authorities. After you obtain copies of the relevant codes and have them translated into English, you will likely discover that you have to use unfamiliar, locally produced products and materials in the design since only these have been certified to meet the local requirements. Many of the code allowances available in the U.S., when fire sprinklers, alarms, and smoke control systems are used, are unavailable under these prescriptive codes, especially in Asia.

Sound like a challenge? By the end of the decade this might be a task requiring only a single design analysis package that will be acceptable nearly anywhere in the world. The International Council for Building Research (CIB), Working Commission 14 (chaired by the author) is developing a common method of fire safety engineering analysis to underpin performance-based fire codes. There is a parallel effort under CIB Task Group 11 to coordinate the development of performance-based building codes. This is part of a worldwide interest in moving away from prescriptive codes driven by a desire to make the regulatory process more flexible and more cost effective. Programs to develop performance codes are under way in Eastern and Western Europe, North America, and across the Pacific Rim.

The Building and Fire Research Laboratory (BFRL) at the National Institute of Standards and Technology (NIST) is recognized as a leader in predictive fire models and their application to fire hazard and fire risk assessment. The evolution of these analytical tools over the past decade has allowed the transition to performance-based codes. Quantitative determinations can now be made as to whether a given design meets explicit performance objectives.

Code Equivalency

Alternative approaches to fire safety around the world were examined under the "equivalency clauses" in the codes. Under these clauses, the architect must convince the local authority that the difference from the prescriptive requirement still meets the intent of the code. In recent years it has become common to use analytical methods to justify variances from code requirements. Most code officials with whom we have spoken are willing to accept such analyses when they are sufficiently documented. In some high-profile projects the regulators have sought second opinions

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from independent parties to increase their confidence.

Performance Objectives

Performance-based codes have several advantages over these ad hoc methods. First, the code objectives are clearly stated and understood by all parties. Second, the analytical methods, data, and assumptions are formalized in a “code of practice,” avoiding disagreements over procedures. Third, the former, prescriptive requirements are retained as "deemed to satisfy" provisions, providing continuity and a simpler method for the majority of projects where a performance analysis may not be warranted.

The greatest appeal of performance codes is the provision of explicit objectives independent of the methods used to achieve them. These objectives are universally based on the concepts of protection of life and property, with some variations for cultural and societal differences. For example, in their new performance code New Zealand decided that the code should not require that owners protect their property from a fire. Insurance carriers now set such requirements as a condition of coverage.

Under a performance code the designer is free to use any means to assure that the occupants of a building can be safely evacuated. Codes of practice are being developed that provide guidance on characterizing fires, occupant loading and characteristics, and other parameters as a function of occupancy type. For example, in a mercantile occupancy in Australia several types of fires, numbers of customers (including the mix of disabled) and allowances for staff training and fire department response are all specified. These are used as design criteria in the same way design loads are.

Fire scenarios likely to occur in the given region are based on actual experience, and so vary from country to country. The frequency of these scenarios is accounted for in the analysis, producing a result that represents the risk of life loss by fire. For instance, the weight given to an arson scenario in an office building in Japan’s fire code is lower than it is in England, reflecting Japan's lower rate of arson.

The ultimate criteria for acceptability of any design reflect the degree to which society accepts fire risk; either implicitly in the risk presented by building designs considered acceptable under the prescriptive code, or explicitly under performance codes. Thus, individual countries will establish their own criteria and a common evaluation method will be used to establish compliance. Several years ago an architect fought a protracted battle with code officials in London over the use of a textile roofing system proposed for a covered shopping area. The material had a coating proported to have high toxicity when exposed to fire. Under the new UK performance code and engineering code of practice this arrangement could easily be shown to be acceptable.

Resistance to Change

There are those who are uncomfortable with changing a system they feel is working well. Regulators are overwhelmed by the complexity of performance-based analysis, and lawmakers are reluctant to acknowledge that some losses are inevitable, even in code-compliant buildings. Material and product producers have also grown comfortable with traditional test methods and their ability to produce products that pass. However, in every country where performance codes have been introduced experience has shown these fears to be unfounded. For example, new product test methods require measurement of a product's reaction to fire and its acceptability, dependent on the context of use, as opposed to universal acceptance.

In spite of these concerns the process is clearly moving forward. The widespread desire for regulatory reform is attributed to the perception that in an increasingly competitive world, prescriptive codes limit economic development. The promise of more open international markets is softening the position of manufacturers. U.S. leadership, with regard to both analytical methods and their application to modern building fire safety design, is leading to increased design business in other countries.. Some U.S. fire protection consulting firms cite this view as the reason for significant growth in the demand for engineered designs for high-rise buildings in the Pacific Rim and South America. Because the U.S. is now viewed as a leader in this area, U.S. architects can use this knowledge to better sell their services for work abroad.

Next Steps

While the U.S. is a leader in analytical methods and their application to modern building fire safety design, by most accounts America is lagging behind other countries in the transition to performance codes. The U.S. has a multiplicity of codes instead of a single, national code common in many countries. The three model code organizations, plus the Society of Fire Protection Engineers and the National Fire Protection Association, are studying what their role should be and how they can encourage the transition. Beyond overhauling the codes and standards process, the task of educating architects, engineers, code officials, and builders is daunting. Generally, designing to specific performance levels for energy, acoustical, environmental, fire, and others will result in more dependence on specialty engineering. But performance codes will all demand increased understanding by the architect coordinating these consultants. Expertise in performance codes will also provide the architect with another valuable service for a global array of clients.

Testing laboratories are struggling with the need to move from providing lists of acceptable products to providing the certified performance data needed by these new methods. Professional societies are examining their roles in providing peer review of the evolving methods and the development of the needed codes of practice. We are in a period of rapid technological change and all parties need to work together to assure that the evolution goes smoothly.

BFRL sees its role as developing and verifying the predictive tools as well as providing a national focus in the international standards arena. As part of NIST, we assist industry in technological development and in remaining competitive. We welcome the opportunity to work with the design community through the American Institute of Architects and other organizations.

Final Thoughts

Making the advance to performance-based fire codes in this country is going to take a coordinated effort by all of the institutions and organizations with stakes in the process. Clearly, the model code groups and professional societies are trying to shape their role. Code officials are dealing with increasingly complex, alternate design analyses, and many of them are gaining confidence in the accuracy of such methods. BFRL is continuing to invest in advancing the technology and in integrating our analytical tools with CAD to encourage the use of these tools by the design community. For example, we are working on linking our fire models to architectural CAD software so that proposed designs can be evaluated in the architect’s office. By moving to a system where the ultimate performance is clear, the methods to meet that level of performance are left to the expertise of the designer. Without prescriptive codes and greater choice for the architect, it should be possible to produce more cost effective buildings with no sacrifice in fire safety.

With worldwide acceptance of a common evaluation method, it should no longer be necessary to deal with a range of sometimes conflicting local code requirements. This should go a long way toward the elimination of barriers to trade in the design and construction industries.

For More Information

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